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An Assessment of Korean Students' Environmental Literacy

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Abstract: This study was initiated to understand what students know, how they feel, and how they act in the perspectives of environmental literacy. This study takes it a very serious problem that there has been no data about Korean students' status of environmental literacy so far. Based on the correct diagnosis of Korean students' environmental literacy, environmental education in Korea, including national curriculum, teaching materials and strategy, would take the right way. This study accepts Simmon (1995)'s framework of environmental literacy, consisting of 5 areas, environmental knowledge, skills, affect, and behavior, which is consistent with general goals of environmental education. This study analyzed the relationship between areas in environmental literacy and factors contributing to improving students' environmental literacy. This study also checked which factors, including age, gender, parents' schooling, environmental education in schools, and students' science-related attributes, contributed to improving students' environmental literacy. The results of this study will help science educators keep in mind how important it is to teach science from the perspectives of environmental literacy.

Keywords: environmental literacy, environmental education, factors

Introduction

Scientific literacy has been one of the major issues in science education fields since early 1980s. In the same manner, environmental literacy is arising as the major issue in environmental education field since 1990s. The term "environmental literacy" has been used since the late 1960s, but it had continued to lack precise definition until Roth (1992) clearly defined it. Environmental literacy refers to an individual's knowledge about and attitudes toward the environment and environmental issues; skills and motivation to work toward the resolution of environmental problems and active involvement in working towards the maintenance of dynamic equilibrium between the quality of life and quality of environment (Roth, 1992). In Table 1, the factors in environmental literacy are historically summarized.

Shin (2001) elicited a lot of similarities between environmental and earth system education and recommended earth science education to head for more environment-concerned direction. Earth science community should feel the responsibility to play a leading role in adopting factors of environmental education into earth science education. As the first step to reflect environmental concern on earth science education, Shin et al. (2005) developed new earth science curriculum for middle school students. Because the importance of environment-concerned earth science education is discussing in many countries (King, 2001; Shin et al., 2005), we should not hesitate to actively consider some environmental factors in the on-going earth science education.

This study was initiated to understand what students know, how they feel, and how they act in the perspectives of environmental literacy. This study takes it a very serious problem that there has been no data about Korean students' status of environmental literacy so far. At national level, such illiteracy in understanding the status of students' environmental literacy might mislead the environ-

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Table 1. Major historical review of factors in environmental literacy

Iozzi et al. (1990)	Hungerford et al. (1991)	Wisconsin Center for Environmental Education (1992)	Roth (1992)	Simmons (1995)	Wilke (1995)
-Affect -Locus of control -Assumption of personal responsible behavior		-Affective domain(environmental sensitivity, perception) -Additional determinants of environmentally responsible behavior(locus of control, the assumption of personal responsibility)	-Environmental sensitivity -Attitudes and value	-Affect	-Affective
-Knowledge	-Ecological foundations -Perceptions of issues and human value(environmental information)	-Cognitive domains (ecology, environmental problems, investigation of issue and knowledge of action strategy)	-Knowledge	-Ecological knowledge -Socio-political knowledge -Knowledge of environmental issue	-Cognitive: knowledge and skills
	-Investigation and evaluation of issues and solution methods(development of skills)		-Skills	Skills	
-Participation in responsible environmental behavior	-Citizenship behavior(Development of skills)	-Personal and group participation in responsible environmental behavior	-Personal investigation and responsibility -Active participation	-Additional traits of environmentally responsible behavior -Environmentally responsible behavior	-Additional traits of environmentally responsible behavior -Personal and group participation in responsible environmental behavior

mental education policy toward the wrong direction. Without a correct diagnosis of educational status, any educational policy could cause unexpected educational results. Based on the correct diagnosis of Korean students' environmental literacy, environmental education in Korea, including national curriculum, teaching materials and strategy, would take the right way.

This study accepts Simmon (1996)'s framework of environmental literacy (Table 2). In her study, environmental literacy consists of 5 areas, environmental knowledge, skills, affect, and behavior, which are consistent with general goals of environmental education. Because few studies in Korea have been concerned for the relationship between environmental knowledge and attitudes, environmental attitude and behavior, and environmental skills and attitude, etc, this study will analyze the relationship between areas. This result would help us reorganize how the environmental education should be in the future.

Besides the relationship in environmental literacy, this study will also check which factors contribute to improving students' environmental literacy (Table 3). To understand the relationship between environmental education and science education, science-related predictors - science content with preference, relation to science achievement, role of science and technology, and role of scientists - are specifically analyzed. The role of science education in improving students' environmental literacy could be clarified through these results.

Table 2. Environmental literacy framework in this study adopted from Simmons (1995)

Area	Content
Knowledge	- Ecological knowledge : Communicate and apply the major ecological concepts including those focusing on individuals, species, populations, communities, ecosystems, biogeochemical cycles, energy production and transfer, interdependence, niche, adaption, succession, homeostasis, and man as a ecological variable : A knowledge and understanding of how natural system work, as well as of how social systems interface with natural systems : Changing and limiting factors (change as a natural process; biotic and abiotic limits to growth, size, and distribution of population) - Socio-political knowledge : Economic, social, political and ecological interdependence in urban and rural areas : Understand and communicate how human cultural activities (eg. religious, economic, political, social, etc.) influence the environment from an ecological perspective : The relationship between beliefs, political structures, and environmental values of various cultures : Basic component of societal systems : Geographical understanding at the local, regional, and global levels : Patterns of change in society and culture : Structure and scale in societies and culture - Environmental issue knowledge : Various environmentally-related problems and issues (local, regional, national, international, and global) : Air quality (ozone depletion, global warming, acid deposition, air pollution) : Water quality and quantity (water pollution, use and management) : Soil quality and quantity (soil depletion and pollution, use and management) : Wildlife and habitat : Energy : Land use : Human population and health : Waste
Skills	- Identifying and defining problems : The skills required to analyze, synthesize, and evaluate information about environmental problems/issues using primary and secondary sources, and to evaluate a select problem/issue on the basis of evidence and personal values : Skills for dealing with action strategies: including selecting appropriate action strategies, creating an action plan, evaluating an action plan, and implementing an action plan - Conducting basic risk analysis - Thinking in terms of systems - Using ability to forecast, to think ahead, plan
Affect	- Environmental sensitivity or appreciation - Attitudes: toward pollution, technology, economics, conservation, and environmental action - Willingness to recognize and choose among differing value perspectives associated with problems and issues - Motivation to actively participate in environmental improvement and protection - Moral reasoning: making decisions and judgements about environmental issues according to one's own sense of morality - Value clarification - Locus of control - Assumption of personal responsibility
Behavior	- Active participation aimed at solving problems and resolving issues - Environmentally sound consumer purchasing (consumerism) - Methods for conserving resources (ecomanagement) - Assisting with the enforcement of environmental regulations (legal action) - Using personal and interpersonal means to encourage environmentally sound practices (persuasion) - Encouraging environmentally sound policies and legislative initiatives (political action)

Table 3. Predictors affecting environmental literacy in this study

Personal background	Openness to the environment	Relation to science subject
gender students' socio-economic status parents' educational level living area	experience of EE concern to the environment source of environment information	science content with preference relation to science achievement role of science and technology role of scientists

Table 4. Composition of environmental literacy items

Grade	Knowledge	Skill	Attitude	Behavior	Background information	Total
3	24	7	22	16	12	71
7	27	9	27	25	14	102
10	24	7	27	28	14	100

Methods

Instrumentation

The development of the instrument was based on previous studies with similar purposes (Hines et al., 1986/1987; Hsu & Roth, 1998; Marcinkowski, 1998; Marcinkowski & Rehring, 1995; Sia et al., 1985/1986; Sivek & Hungerford, 1980/1990; Wisconsin Environmental Education Board, 1997). In each school level, tens of items used in similar previous studies were analyzed, at first. Then we selected proper items that assess five areas of environmental literacy used in this study. In the process of item selection, we considered neither whether students learn them in their schools nor whether the items are included in the 7th curriculum. That is because we tried to assess Korean students' environmental literacy at the international standard instead of the national standard, which enables us to suggest where our environmental education should head for in the future.

Selected items were translated from English into Korean version and reviewed by two experts in environmental education to establish content validity. Some items were modified according to their recommendations. Fifty or more students at each school level which show similar socio-economic and educational status with those in the main study were participated in the pilot study to validate items. The results of pilot study were used for internal consistency. Items were analyzed by the adjusted item-to-total correlation. By selecting only those items with reasonably strong item-to-total correlations ($r>0.4$), the researchers could be more confident that the selected items were all measuring the same trait. Number of items were finally determined as in Table 4. Environmental knowledge and skill items were taken as a form of multiple-choice and environmental attitude and behavior items are taken as a form of 4-point Likert-scale.

Data collection and Analysis

Samples were collected within Seoul and Kyunggi-do area. For sampling, we first divided students' living area into three categories, rural, urban, and metropolitan. Three schools in each school level were sampled from rural, urban, and metropolitan areas. Samples were then drawn in proportion with the population in each area. A total of 2,993 students participated in this study (Table 5).

We sampled the 3rd grade students to understand students' environmental literacy at the status before they learn science in schools, 7th grade students to understand students' environmental literacy at the

Table 5. Number of samples

Grade	Seoul	Urban	Rural	Total
3	475	400	94	969
7	464	400	123	987
10	559	335	143	1037
Total	1498	1135	360	2993

status after they learn science in elementary level, and 10th grade students to understand students' environmental literacy at the status after they learn science in middle school level. SPSS 10.0 version was used to analyze the whole data.

Results and Discussions

Relation between areas in environmental literacy

The corelation between areas in environmental literacy show a various trend (Table 6). Regardless of students' school grade, the highest corelation appeared in the relation between environmental attitudes and behavior (.520-.661). The corelation between environmental knowledge and skills were relatively high (.337-.422). It it noteworthy that the corelation between environmental skills and behavior was low (.039-.082) in all three grades. The corelation between environmental knowledge and behavior was also low (.095.107). The corelation between environmental attitudes and knowledge and that between environmental attitudes and skills was moderate.

This result shows a significant fact that environmental behavior is closely related to environmental attitudes whereas environmental knowledge and skills do not play an important role in improving environmental responsible behavior. It is also interesting to note that environmental knowledge and skills are closely related, which means the acquisition of environmental knowledge cause the proper environmental skills.

Factors affecting environmental literacy

Table 7 represents which factors affect students' environmental literacy. For young students, Students' gender did affect their environmental literacy: Female students in grade 3 showed significantly higher environmental knowledge, skills, attitudes, and behavior. In grades 7 and 11, there was few significant difference between genders in environmental literacy including environmental knowledge, which is in contrast with the results of male students' superiority in scientific literacy knowledge (Shin & Noh, 2002). It is interesting to note that female students showed significantly positive environmental attitudes in grade 11.

Parents' schooling appeared to play an important role in improving students' environmental literacy, especially for the younger students. Students with college-graduate parents did show a significantly higher environmental knowledge, skills, attitudes, and behavior. However, parents' schooling influence did not appear for the older students.

Environmental education in schools had an effect on improving students' environmental literacy at all grade levels. Students who had experiences of environmental education in school showed a significantly positive environmental literacy. In particular, environmental education took a great effect on stu-

Table 6. Corelation in areas of environmental literacy (N=2,993)

	Grade	Knowledge	Skills	Attitude	Behavior
Knowledge	3	1.000			
	7	1.000			
	11	1.000			
Skills	3	.337	1.000		
	7	.422	1.000		
	11	.369	1.000		
Attitude	3	.238	.211	1.000	
	7	.252	.268	1.000	
	11	.290	.248	1.000	
Behavior	3	.107	.039	.562	1.000
	7	.095	.082	.661	1.000
	11	.097	.081	.520	1.000

Table 7. Significant factors affecting environmental literacy

Area / Factor	Knowledge			Skills			Attitudes			Behavior		
Grade	3	7	11	3	7	11	3	7	11	3	7	11
Gender	F>M	NS	NS	F>M	F>M	NS	F>M	NS	F>M	F>M	NS	NS
Living area	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Father's schooling	C>H	C>H	NS	C>H	C>H	NS	C>H	C>H	NS	C>H	NS	NS
Mother's schooling	C>H	C>H	NS	C>H	C>H	C>H	C>H	NS	NS	C>H	NS	NS
Experience of EE	NS	yes>no	NS	NS	yes>no	NS	yes>no	yes>no	yes>no	yes>no	yes>no	yes>no
Information source	outdoor learning, books	newspaper/magazine, books	family, field trip	outdoor learning, books	newspaper/magazine, TV	newspaper/magazine, family	outdoor learning, newspaper/magazine	family, books	field trip, newspaper/magazine	outdoor learning, newspaper/magazine	newspaper/magazine, books	field trip, newspaper/magazine
Science achievement	NS	NS	NS	NS	NS	NS	G>NG	NS	NS	G>NG	NS	NS
Science subject of preference	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Opinion of science	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note 1) F: Female, M: Male, NS: Not Significant, C: College graduate, H: High school graduate, G: Good, NG: Not good,
Note 2) A>B: A shows significantly higher achievement than B at .05 significance level.

dents' environmental attitude and behavior. That means environmental education in schools should be more emphasized in the future.

Students' science-related attributes nearly affected on their environmental literacy at all grade levels. Neither students' cognitive nor their affective perspectives in science had relationship with their environmental literacy. However, third-grade students' attitudes and behavior were affected by their science achievement. This means that traditional science-related enterprises have not contributed to improving students' environmental literacy, which results imposing a new need for changing on science educators.

Conclusion

The common results shown from elementary to high schoolers in environmental literacy were as followings. First, whereas the relationship between environmental attitudes and behavior was high, the relationship between environmental knowledge and behavior was low. Second, the experience in environmental education had an effect on students' environmental literacy, regardless of the content and method in environmental education. Third, the higher students' science achievement, the higher their environmental literacy.

Elementary students' environmental literacy was especially affected by gender and learning method: female students rather than male students and outdoor education rather than classroom learning were in positive position toward students' environmental literacy. Middle schoolers' environmental literacy was especially affected by their parents' schooling and high schoolers' environmental literacy was especially affected by their mother's schooling.

The importance of role of science in improving students' environmental literacy arose again in this study. In particular, the fact that earth literacy is closely related to environmental literacy leave us, as earth science educators, a lot of work to do for solving serious environmental problems. This kind of assessment in environmental literacy is expected to be periodically carried out for fulfilling our society's educational needs.

References

Hines, J.M., Hungerford, H.R., & Tomera, A.N. (1986/1987). Analysis and synthesis of research on responsible environmental behavior: a meta-analysis. Journal of Environmental Education, 18 (2), 1-8.

Hsu, S. & Roth, R.E. (1998). An assessment of environmental literacy and analysis of predictors of responsible environmental behavior held by secondary teachers in the Hualien area of Taiwan. Environmental Education Research, 4 (3), 229-249.

Marcinkowski, T.J. (1998). An analysis of correlates and predictors of responsible environmental behavior. Unpublished doctoral dissertation, Southern Illinois University at Carbondale.

Marcinkowski, T.J. & Rehring, L. (1995). The secondary school report: A final report on the development, pilot testing, validation, and field testing of the secondary school environmental literacy assessment instrument. Office of Research and Development, US Environmental Protection Agency.

Roth, C.E. (1992). Environmental literacy: its roots, evolution, and directions in the 1990s. (Columbus, OH, ERIC/SMEAC Information Reference Center).

Shin, D. (2001). Earth science in the perspectives of environmental education. Journal of Korean Earth Science Society, 22 (2), 147-158.

Shin, D. & Noh, K. (2002). Korean students' scientific literacy. Journal of the Association of Research in Science Education, 22 (1), 76-92.

Shin, D., Lee, Y., Lee, K., Lee, E., and Lee, K. (2005). Identification of the future-oriented earth science education placing on the "earth environment". Journal of the Korean association of Research in Science Education, 25 (1), 239-259.

Sia, A.P., Hungerford, H.R., & Omera, A.N. (1985/1986). Selected predictors of responsible environmental behavior: an analysis. Journal of Environmental Education, 17 (2), 31-40.

Simmons, D. (1995). The NAAEE standards project. University in Dekalb: Illinois.

Sivek, D.J. & Hungerford, H.R. (1989/1990). Predictors of responsible behavior in members of three Wisconsin conservation organizations. Journal of Environmental Education, 21 (2), 35-40.

Wisconsin Environmental Education Board (1997). Are we walking the talk? Wisconsin Center for Environmental Education.

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